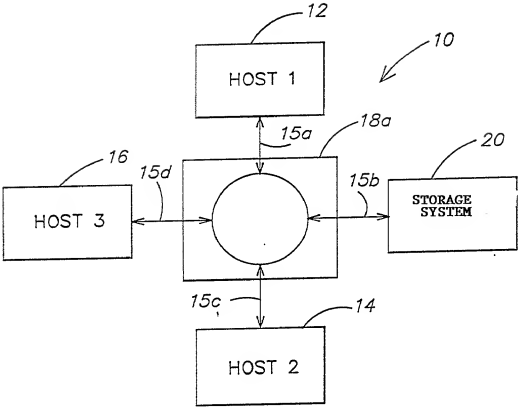

12
10
HOST 1
15a
18a
20
16
15d
15b
HOST 3
STORAGE SYSTEM
15c
14
HOST 2

FIG. 1A

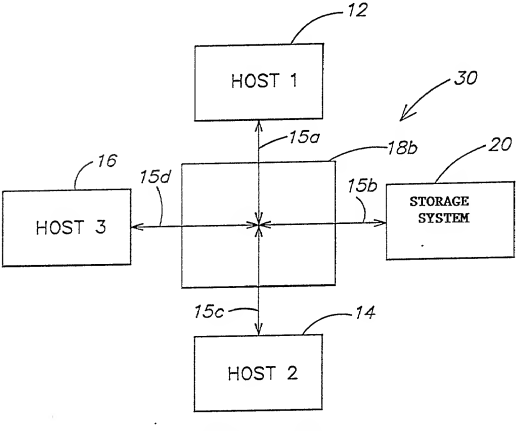

12
HOST 1
30
15a
18b
20
16
15d
15b
HOST 3
STORAGE SYSTEM
15c
14
HOST 2

FIG. 1B

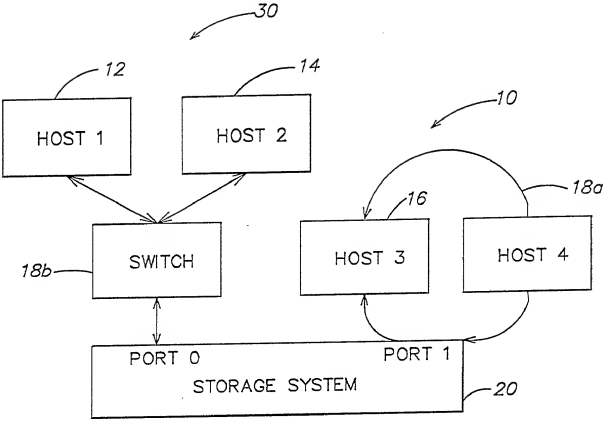

30
12
14
10
HOST 1
HOST 2
18a
16
18b
SWITCH
HOST 3
HOST 4
PORT 0
PORT 1
STORAGE SYSTEM
20

FIG. 1C

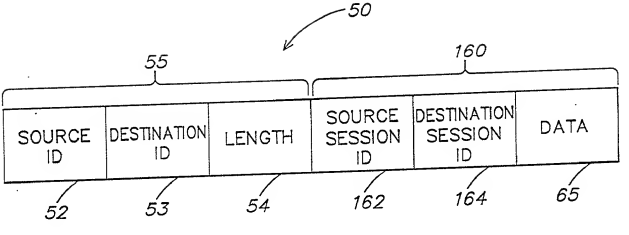

50
55
160
SOURCE ID
DESTINATION ID
LENGTH
SOURCE SESSION ID
DESTINATION SESSION ID
DATA
52
53
54
162
164
65

FIG. 2

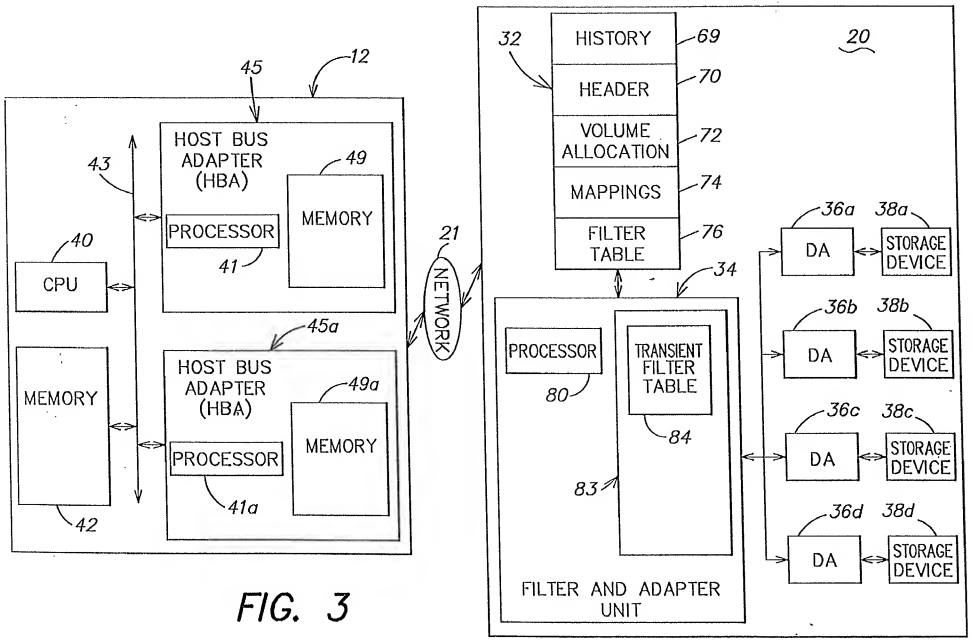

45
12
HOST BUS ADAPTER (HBA)
43
49
PROCESSOR
MEMORY
41
40
CPU
21
NETWORK
45a
HOST BUS ADAPTER (HBA)
MEMORY
49a
PROCESSOR
MEMORY
41a
42
32
HISTORY
69
20
HEADER
70
VOLUME ALLOCATION
72
MAPPINGS
74
FILTER TABLE
76
34
36a
38a
DA
STORAGE DEVICE
36b
38b
DA
STORAGE DEVICE
36c
38c
DA
STORAGE DEVICE
36d
38d
DA
STORAGE DEVICE
PROCESSOR
80
TRANSIENT FILTER TABLE
84
83
FILTER AND ADAPTER UNIT

FIG. 3

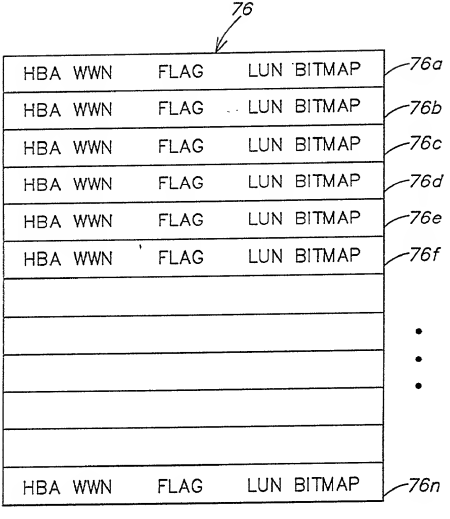

76
HBA WWN FLAG LUN BITMAP
76a
HBA WWN FLAG LUN BITMAP
76b
HBA WWN FLAG LUN BITMAP
76c
HBA WWN FLAG LUN BITMAP
76d
HBA WWN FLAG LUN BITMAP
76e
HBA WWN FLAG LUN BITMAP
76f
HBA WWN FLAG LUN BITMAP
76n

FIG. 4

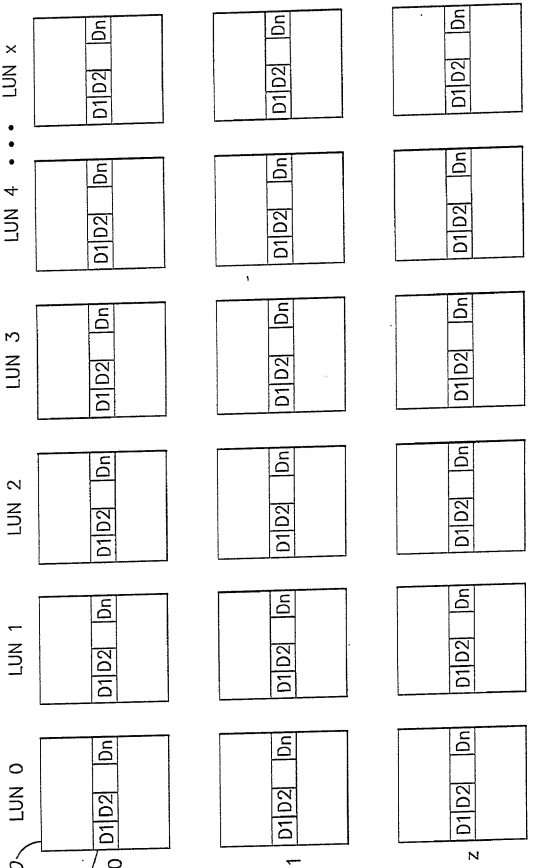

400
402
LUN 0
LUN 1
LUN 2
LUN 3
LUN 4
LUN x
PORT 0
PORT 1
PORT z
D1
D2
Dn

FIG. 5

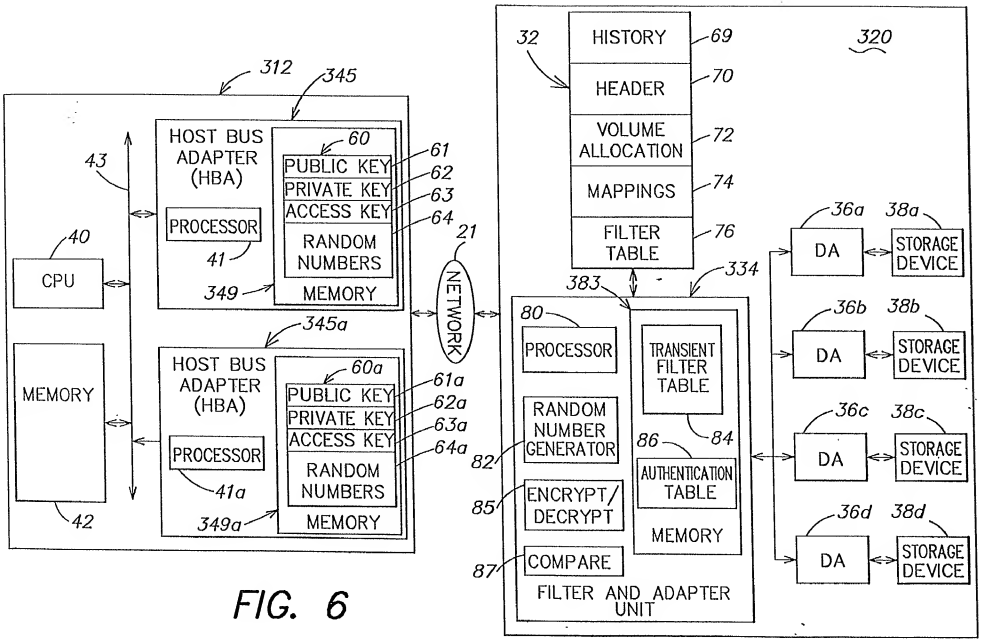

312
345
HOST BUS ADAPTER (HBA)
60
PUBLIC KEY
PRIVATE KEY
ACCESS KEY
RANDOM NUMBERS
MEMORY
61
62
63
64
43
PROCESSOR
41
349
40
CPU
MEMORY
42
21
NETWORK
345a
HOST BUS ADAPTER (HBA)
60a
PUBLIC KEY
PRIVATE KEY
ACCESS KEY
RANDOM NUMBERS
MEMORY
61a
62a
63a
64a
PROCESSOR
41a
349a
32
HISTORY
69
HEADER
70
VOLUME ALLOCATION
72
MAPPINGS
74
FILTER TABLE
76
320
383
334
80
PROCESSOR
TRANSIENT FILTER TABLE
84
RANDOM NUMBER GENERATOR
82
86
AUTHENTICATION TABLE
85
ENCRYPT/ DECRYPT
MEMORY
87
COMPARE
FILTER AND ADAPTER UNIT
36a
38a
DA
STORAGE DEVICE
36b
38b
DA
STORAGE DEVICE
36c
38c
DA
STORAGE DEVICE
36d
38d
DA
STORAGE DEVICE

FIG. 6

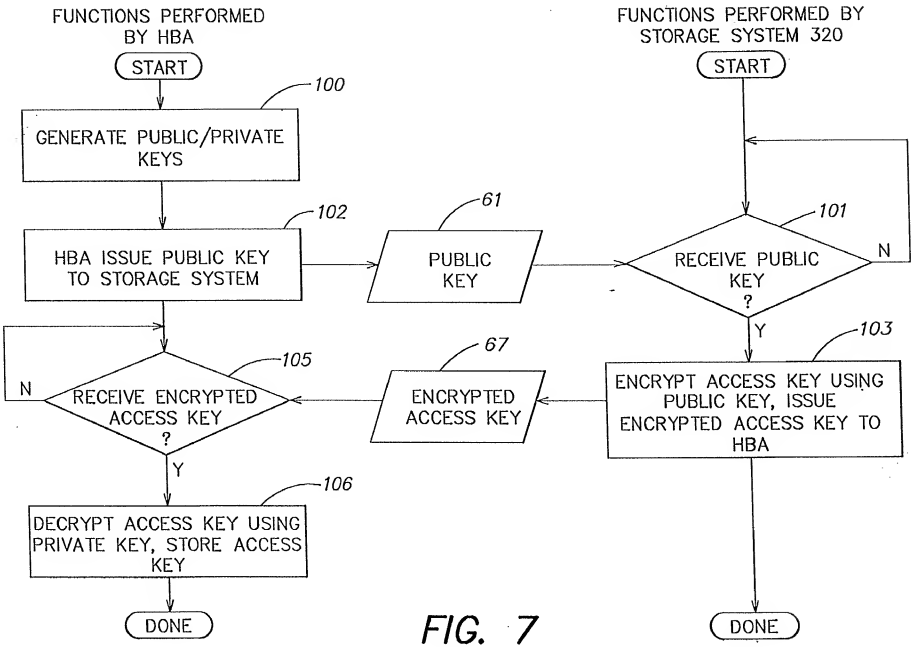

FUNCTIONS PERFORMED BY HBA
START
100
GENERATE PUBLIC/PRIVATE KEYS
102
HBA ISSUE PUBLIC KEY TO STORAGE SYSTEM
61
PUBLIC KEY
FUNCTIONS PERFORMED BY STORAGE SYSTEM 320
START
101
RECEIVE PUBLIC KEY ?
N
Y
103
ENCRYPT ACCESS KEY USING PUBLIC KEY, ISSUE ENCRYPTED ACCESS KEY TO HBA
67
ENCRYPTED ACCESS KEY
105
N
RECEIVE ENCRYPTED ACCESS KEY ?
Y
106
DECRYPT ACCESS KEY USING PRIVATE KEY, STORE ACCESS KEY
DONE
DONE

FIG. 7

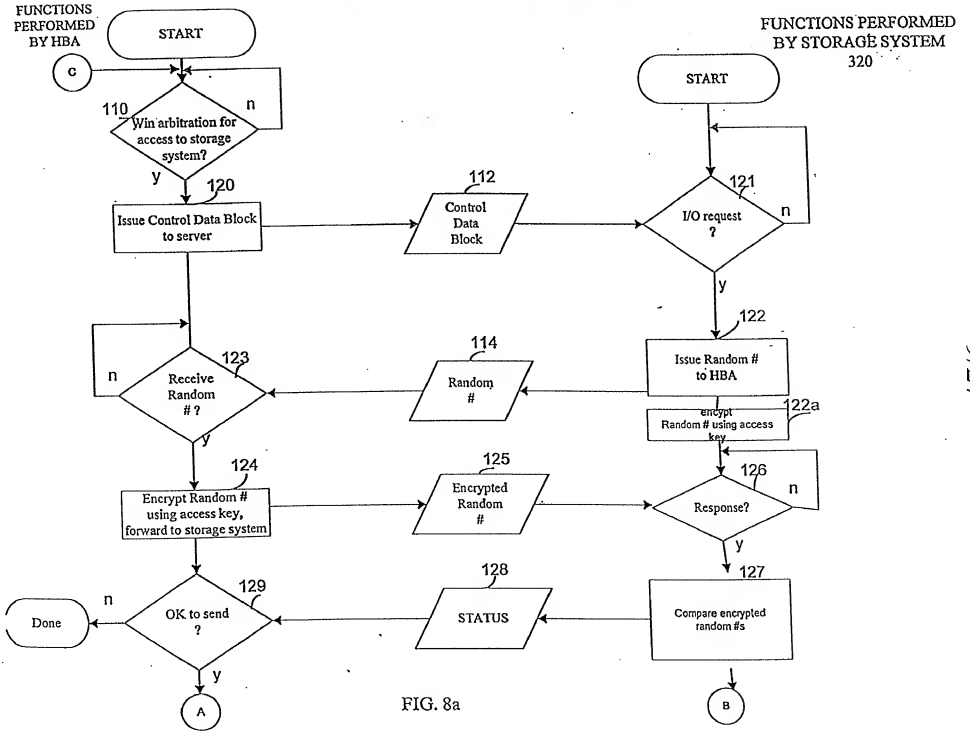

FUNCTIONS PERFORMED BY HBA
START
C
110
Win arbitration for access to storage system?
n
y
120
Issue Control Data Block to server
112
Control Data Block
FUNCTIONS PERFORMED BY STORAGE SYSTEM 320
START
121
I/O request ?
n
y
122
Issue Random # to HBA
122a
encrypt Random # using access key
114
Random #
123
Receive Random # ?
n
y
124
Encrypt Random # using access key, forward to storage system
125
Encrypted Random #
126
Response?
n
y
127
Compare encrypted random #s
128
STATUS
129
OK to send ?
n
Done
y
A
B

FIG. 8a

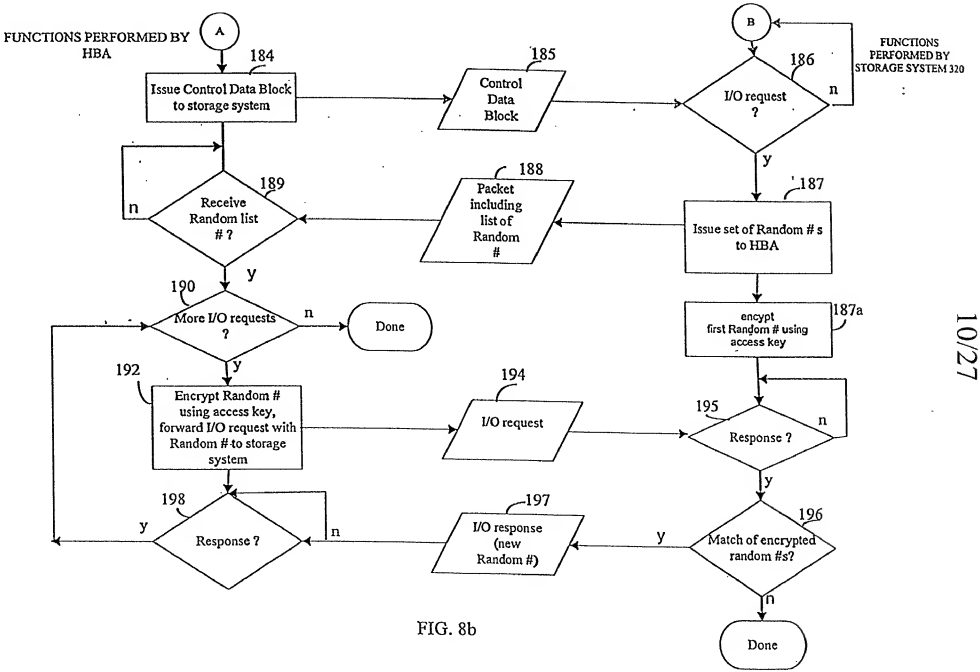

FUNCTIONS PERFORMED BY HBA
A
184
Issue Control Data Block to storage system
185
Control Data Block
B
FUNCTIONS PERFORMED BY STORAGE SYSTEM 320
186
I/O request ?
n
y
187
Issue set of Random # s to HBA
187a
encypt first Random # using access key
188
Packet including list of Random #
189
Receive Random list # ?
n
y
190
More I/O requests ?
n
Done
y
192
Encrypt Random # using access key, forward I/O request with Random # to storage system
194
I/O request
195
Response ?
n
y
196
Match of encrypted random #s?
y
n
Done
197
I/O response (new Random #)
198
Response ?
y
n

FIG. 8b

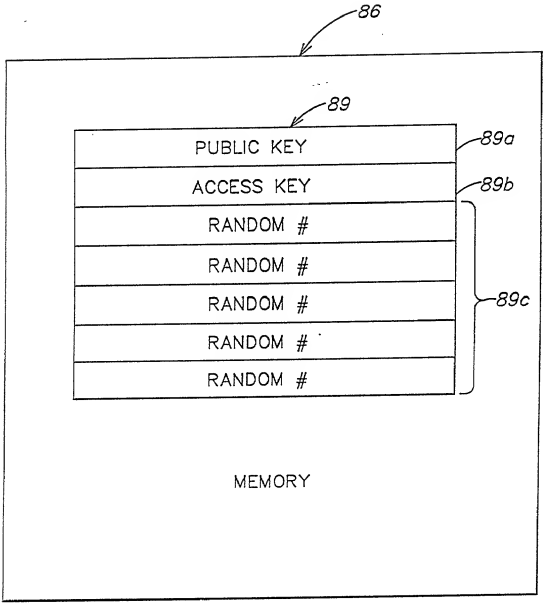

86
89
PUBLIC KEY
ACCESS KEY
RANDOM #
RANDOM #
RANDOM #
RANDOM #
RANDOM #
89a
89b
89c
MEMORY

FIG. 9

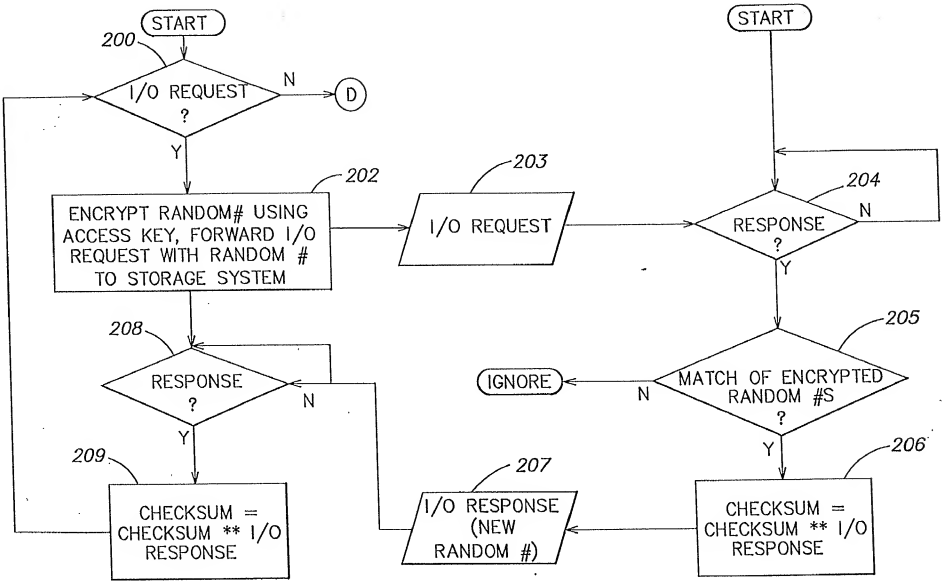
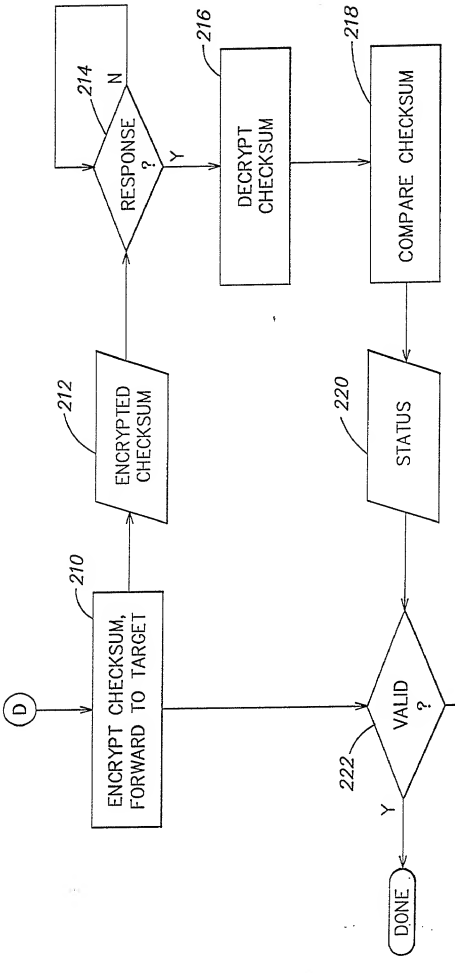

START
200
I/O REQUEST ?
N
D
Y
202
ENCRYPT RANDOM# USING ACCESS KEY, FORWARD I/O REQUEST WITH RANDOM # TO STORAGE SYSTEM
208
RESPONSE ?
N
Y
209
CHECKSUM = CHECKSUM ** I/O RESPONSE
203
I/O REQUEST
207
I/O RESPONSE (NEW RANDOM #)
START
204
RESPONSE ?
N
Y
205
MATCH OF ENCRYPTED RANDOM #S ?
IGNORE
N
Y
206
CHECKSUM = CHECKSUM ** I/O RESPONSE

FIG. 10


D
210
ENCRYPT CHECKSUM, FORWARD TO TARGET
212
ENCRYPTED CHECKSUM
214
RESPONSE ?
N
Y
216
DECRYPT CHECKSUM
218
COMPARE CHECKSUM
220
STATUS
222
VALID ?
N
Y
C
DONE

(FIG. 8a)

FIG. 11

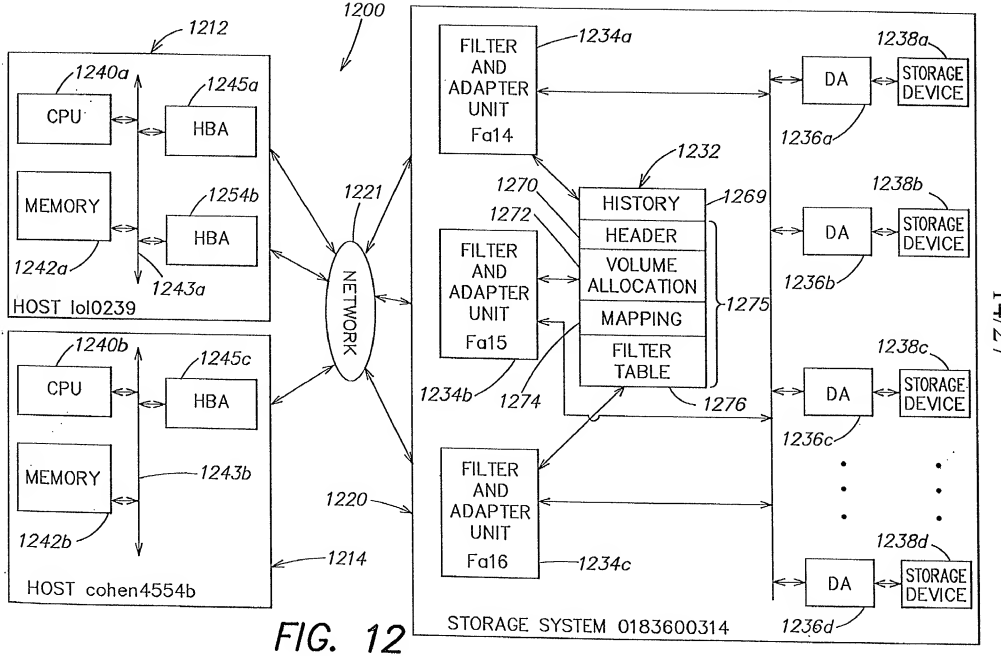

1200
1212
1240a
CPU
1245a
HBA
MEMORY
1254b
HBA
1242a
1243a
HOST lol0239
1240b
CPU
1245c
HBA
MEMORY
1243b
1242b
HOST cohen4554b
1221
NETWORK
1220
1214
FILTER AND ADAPTER UNIT Fa14
1234a
FILTER AND ADAPTER UNIT Fa15
1234b
FILTER AND ADAPTER UNIT Fa16
1234c
1232
1270
1272
HISTORY
1269
HEADER
VOLUME ALLOCATION
MAPPING
FILTER TABLE
1275
1274
1276
DA
1238a
STORAGE DEVICE
1236a
1238b
1236b
1238c
1236c
1238d
1236d
STORAGE SYSTEM 0183600314

FIG. 12

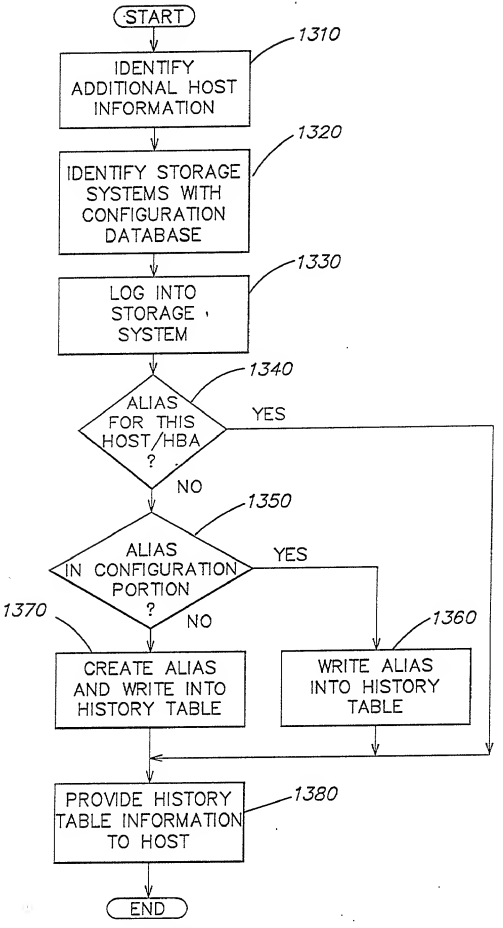

START
1310
IDENTIFY ADDITIONAL HOST INFORMATION
1320
IDENTIFY STORAGE SYSTEMS WITH CONFIGURATION DATABASE
1330
LOG INTO STORAGE SYSTEM
1340
ALIAS FOR THIS HOST/HBA ?
YES
NO
1350
ALIAS IN CONFIGURATION PORTION ?
YES
NO
1370
CREATE ALIAS AND WRITE INTO HISTORY TABLE
1360
WRITE ALIAS INTO HISTORY TABLE
PROVIDE HISTORY TABLE INFORMATION TO HOST
1380
END

FIG. 13

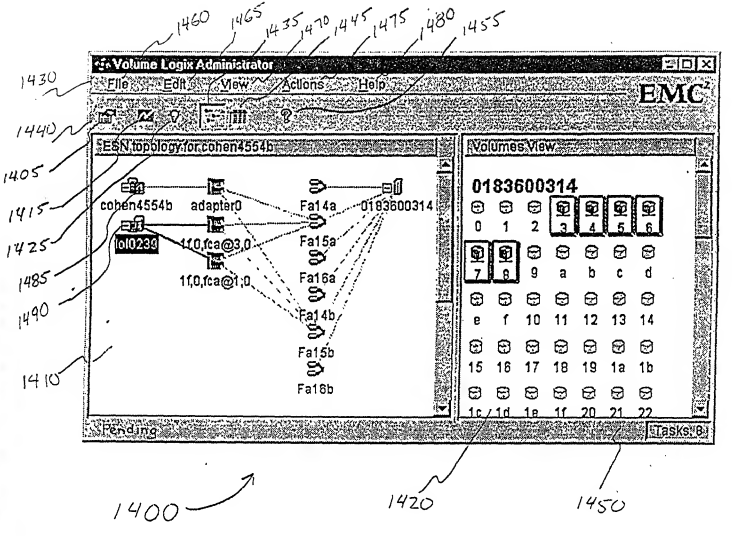

1460
1465
1435
1470
1445
1475
1480
1455
1430
1440
1405
1415
1425
1485
1490
1410
Volume Logix Administrator
File
Edit
View
Actions
Help
EMC
ESN topology for cohen4554b
cohen4554b
adapter0
Fa14a
0183600314
lol0239
1f0,fca@3,0
Fa15a
1f1,0,fca@1,0
Fa16a
Fa14b
Fa15b
Fa18b
Volumes View
0183600314
0 1 2 3 4 5 6
7 8 9 a b c d
e f 10 11 12 13 14
15 16 17 18 19 1a 1b
Pending
Tasks: 8
1400
1420
1450

Fig. 14

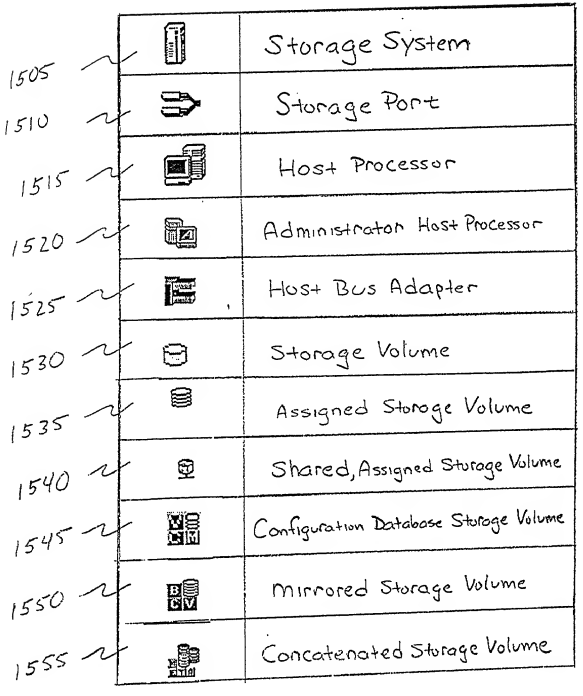

1505
Storage System
1510
Storage Port
1515
Host Processor
1520
Administrator Host Processor
1525
Host Bus Adapter
1530
Storage Volume
1535
Assigned Storage Volume
1540
Shared, Assigned Storage Volume
1545
Configuration Database Storage Volume
1550
Mirrored Storage Volume
1555
Concatenated Storage Volume

Fig. 15

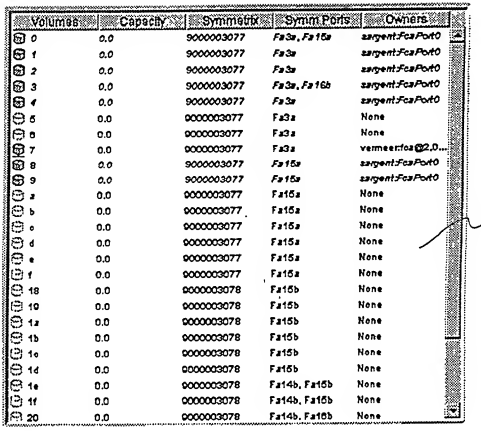

Volumes
Capacity
Symmetrix
Symm Ports
Owners
0 0.0 9000003077 Fa3a, Fa15a sargent:FcaPort0
1 0.0 9000003077 Fa3a sargent:FcaPort0
2 0.0 9000003077 Fa3a sargent:FcaPort0
3 0.0 9000003077 Fa3a, Fa15b sargent:FcaPort0
4 0.0 9000003077 Fa3a sargent:FcaPort0
5 0.0 9000003077 Fa3a None
6 0.0 9000003077 Fa3a None
7 0.0 9000003077 Fa3a vermeer:fca@2.0...
8 0.0 9000003077 Fa15a sargent:FcaPort0
9 0.0 9000003077 Fa15a sargent:FcaPort0
a 0.0 9000003077 Fa15a None
b 0.0 9000003077 Fa15a None
c 0.0 9000003077 Fa15a None
d 0.0 9000003077 Fa15a None
e 0.0 9000003077 Fa15a None
f 0.0 9000003077 Fa15a None
10 0.0 9000003078 Fa15b None
11 0.0 9000003078 Fa15b None
12 0.0 9000003078 Fa15b None
13 0.0 9000003078 Fa15b None
14 0.0 9000003078 Fa15b None
15 0.0 9000003078 Fa15b None
16 0.0 9000003078 Fa14b, Fa15b None
17 0.0 9000003078 Fa14b, Fa15b None
18 0.0 9000003078 Fa14b, Fa15b None
1620

Fig. 16

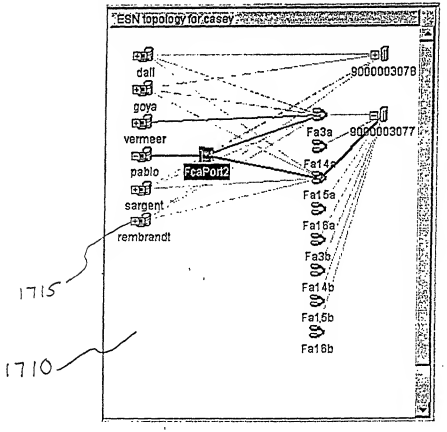

"ESN topology for casey
dali
goya
vermeer
pablo
sargent
rembrandt
FcaPort2
9000003078
9000003077
Fa3a
Fa14a
Fa15a
Fa16a
Fa3b
Fa14b
Fa15b
Fa16b
1715
1710

Fig. 17

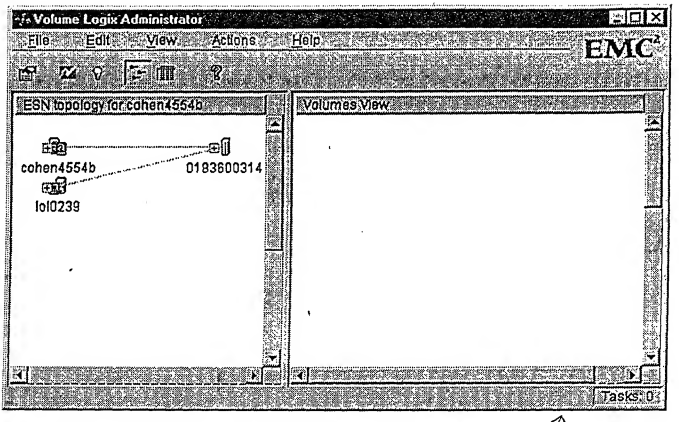

Volume Logix Administrator
File
Edit
View
Actions
Help
EMC
ESN topology for cohen4554b
cohen4554b
0183600314
lol0239
Volumes View
Tasks: 0

Fig. 18

1800

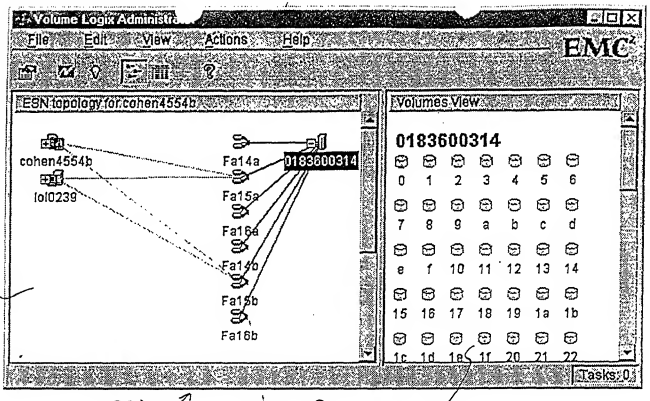
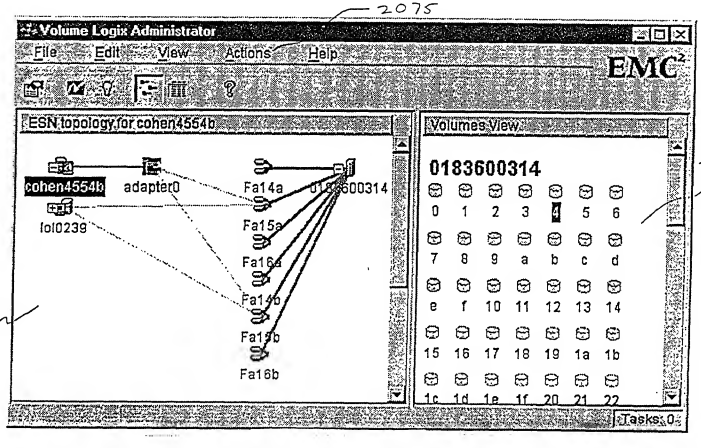

Volume Logix Administrator
File Edit View Actions Help
EMC
ESN topology for cohen4554b
cohen4554b
fol0239
Fa14a
0183600314
Fa15a
Fa16a
Fa14b
Fa15b
Fa16b
Volumes View
0183600314
0 1 2 3 4 5 6
7 8 9 a b c d
e f 10 11 12 13 14
15 16 17 18 19 1a 1b
1c 1d 1e 1f 20 21 22
Tasks: 0
1910
1900
1920

Fig. 19

Fig. 20


2075
Volume Logix Administrator
File Edit View Actions Help
EMC
ESN topology for cohen4554b
cohen4554b
adapter0
fol0239
Fa14a
0183600314
Fa15a
Fa16a
Fa14b
Fa15b
Fa16b
Volumes View
0183600314
0 1 2 3 4 5 6
7 8 9 a b c d
e f 10 11 12 13 14
15 16 17 18 19 1a 1b
1c 1d 1e 1f 20 21 22
Tasks: 0
2010
2020

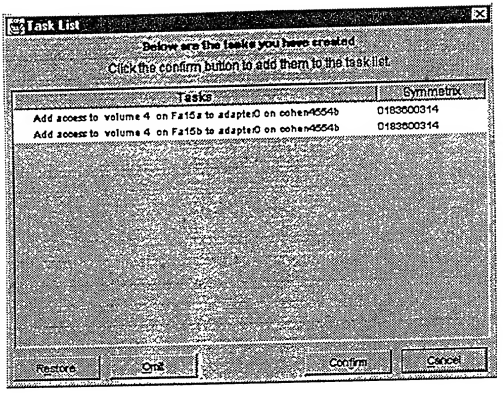

Task List
Below are the tasks you have created.
Click the confirm button to add them to the task list.
Tasks
Symmetrix
Add access to volume 4 on Fa15a to adapterO on cohen4554b
0183600314
Add access to volume 4 on Fa15b to adapterO on cohen4554b
0183600314
Restore
Undo
Confirm
Cancel

Fig. 21

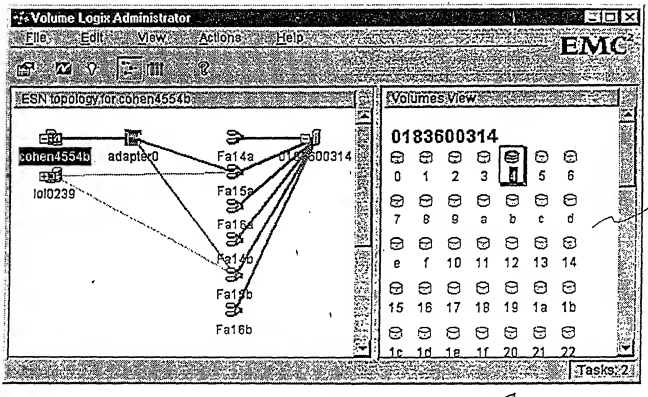

Volume Logix Administrator
File
Edit
View
Actions
Help
EMC
ESN topology for cohen4554b
cohen4554b
adapter0
lol0239
Fa14a
Fa15a
Fa16a
Fa14b
Fa15b
Fa16b
Volumes View
0183600314
0 1 2 3 4 5 6
7 8 9 a b c d
e f 10 11 12 13 14
15 16 17 18 19 1a 1b
1c 1d 1e 1f 20 21 22
Tasks: 2
2220

Fig. 22

2200

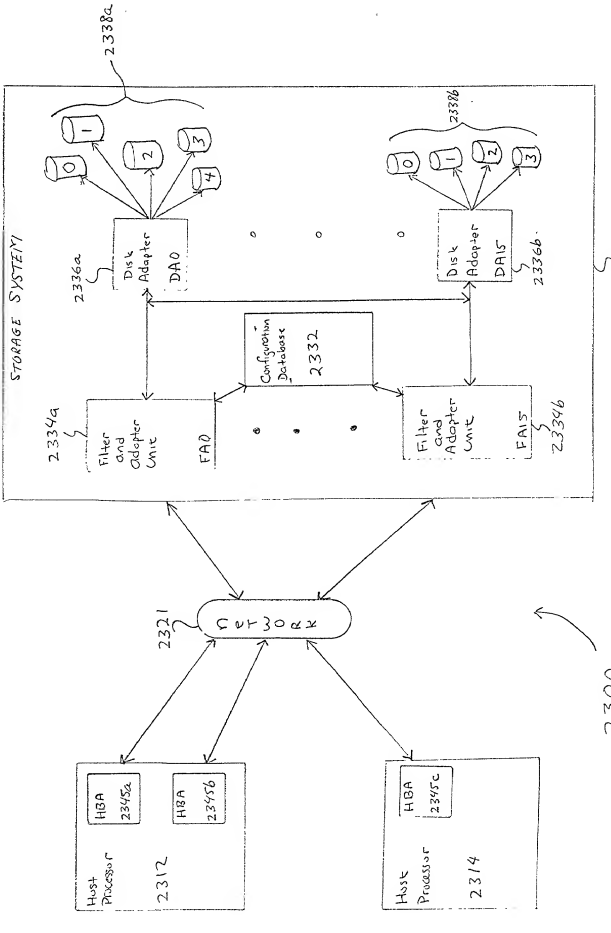

STORAGE SYSTEM
2338a
2338b
2336a
2336b
Disk Adapter
DA0
DA1S
2334a
Filter and Adapter Unit
FA0
FA1S
2334b
Configuration Database
2332
2321
NETWORK
Host Processor
2312
HBA
2314
2300
2320

Fig. 23

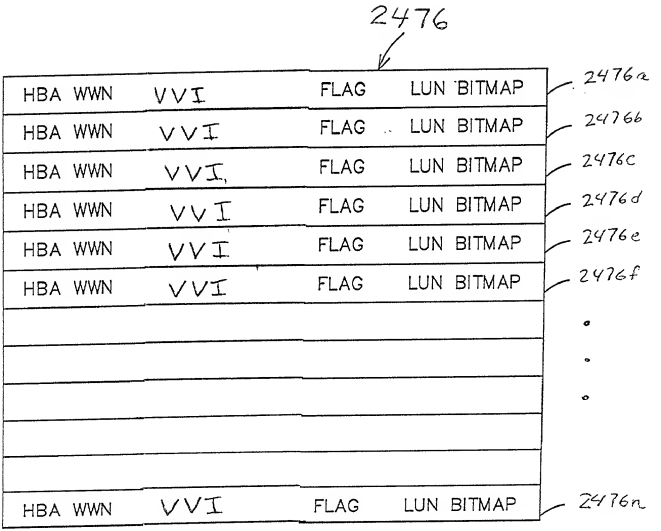

2476
HBA WWN
VVI
FLAG
LUN BITMAP
2476a
2476b
2476c
2476d
2476e
2476f
2476n

Fig. 24

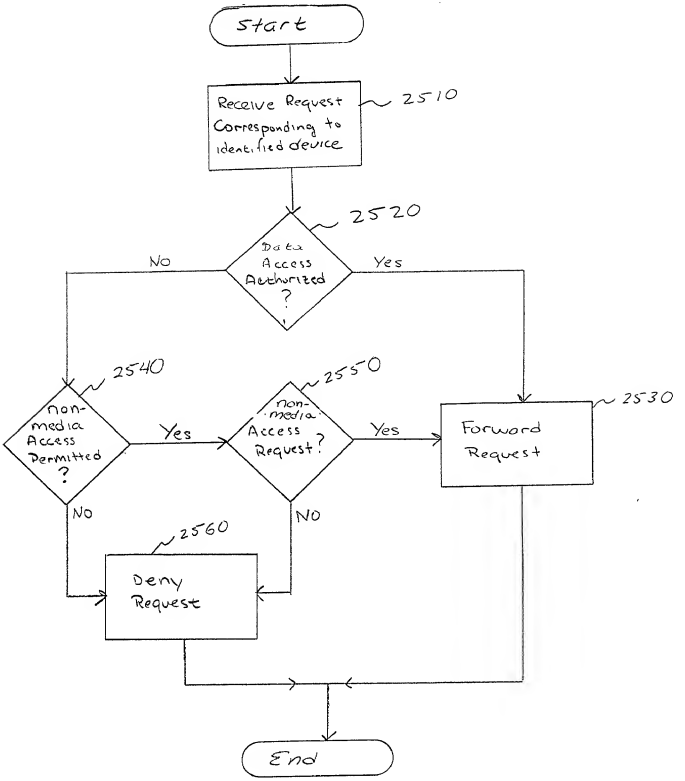

Start
Receive Request Corresponding to identified device
2510
2520
Data Access Authorized ?
No
Yes
2540
Non-media Access Permitted ?
Yes
2550
non-media Access Request?
Yes
2530
Forward Request
No
No
2560
Deny Request
End

Fig 25

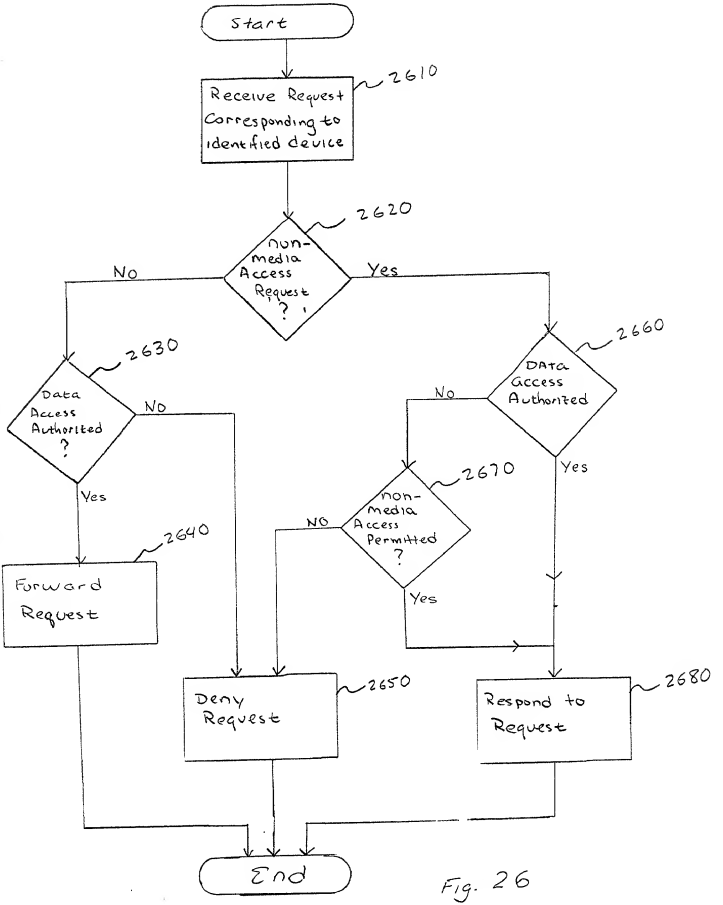

Start
Receive Request Corresponding to identified device
2610
non-media Access Request ?
2620
No
Yes
Data Access Authorized ?
2630
No
Yes
Forward Request
2640
Data Access Authorized
2660
No
Yes
non-media Access Permitted ?
2670
NO
Yes
Deny Request
2650
Respond to Request
2680
End

Fig. 26